

Introduction

"I knew the second I met you that there was something about you I needed. Turns out it wasn't something about you at all. It was just you."

Beautiful Disaster by James McGuire

As the statement says, the lover necessarily needs her beloved to feel complete. That attitude could bring the impression that the beloved is as necessary for the lover as the drug is for the drug addict. Love is often described as an addiction, a subtle metaphor that could contain seeds of truth. Love includes emotional responses as euphoria, intense focused attention on a preferred individual, obsessive thinking about him or her, emotional dependency on someone and craving for the emotional union with the beloved person. In this review, it will be discussed whether love can be seen as an addictive process or this is just a misconceived idea.

Objectives

- To characterize the process of romantic love from a neurobiological point of view
- To characterize the addictive process from a neurobiological perspective
- To compare the two processes in order to find some relationship between them

Materials and Methods

Extended search in PubMed database for recent scientific reviews in order to get a general idea of the subject. Moreover, it has been complemented with scientific articles to reach the opportune specificity required for the project.

Keywords: love, addiction, dopamine, reward system, cocaine

Results

Romantic Love

Romantic love is a motivated mechanism directed to a specific objective, the beloved. It is motivated by a complex cognitive component difficult to characterize. It is a system for mate choice, which helps to select the partner that offers the best possibilities for having healthy children. The final objective is to motivate mating individuals to remain together long enough to rise the children.

Love Neuroanatomy

Activations

Responsible of:

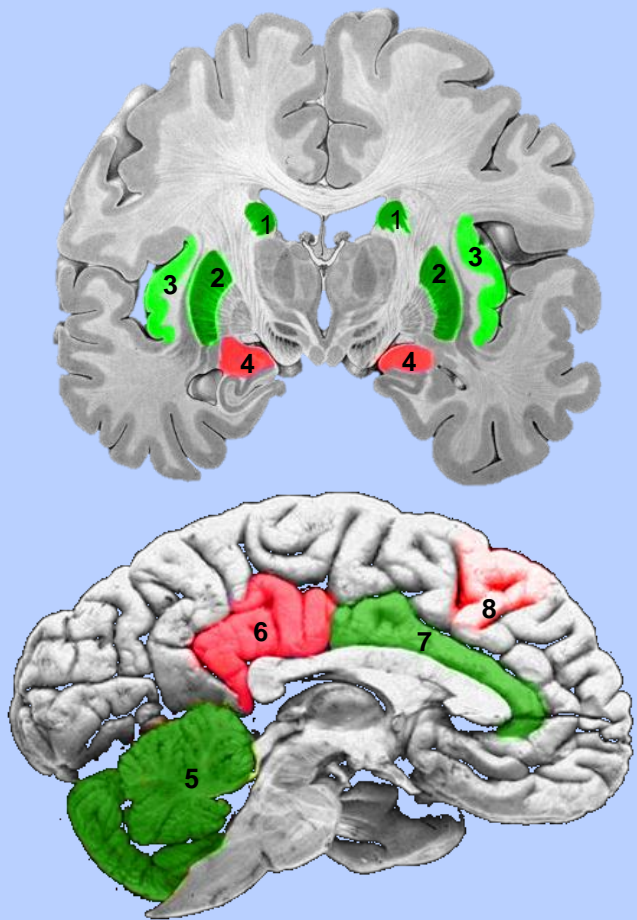
Feelings of reward, euphoria, excitement, happiness

Deactivations

Responsible of:

Judgement suspension, love irrationality

- Accumbens nucleus
- Caudate nucleus (1)
- Putamen nucleus (2)
- Insula (3)
- Cerebellum (5)
- Anterior cingulate gyrus (7)
- Amygdaloid region (4)
- Posterior cingulate gyrus (6)
- Prefrontal cortex (8)



Adapted from: Interactive Neuroanatomy Atlas [webpage]. Available: <http://www.columbia.edu/itc/hs/medical/neuroanatomy/neuroanat/>

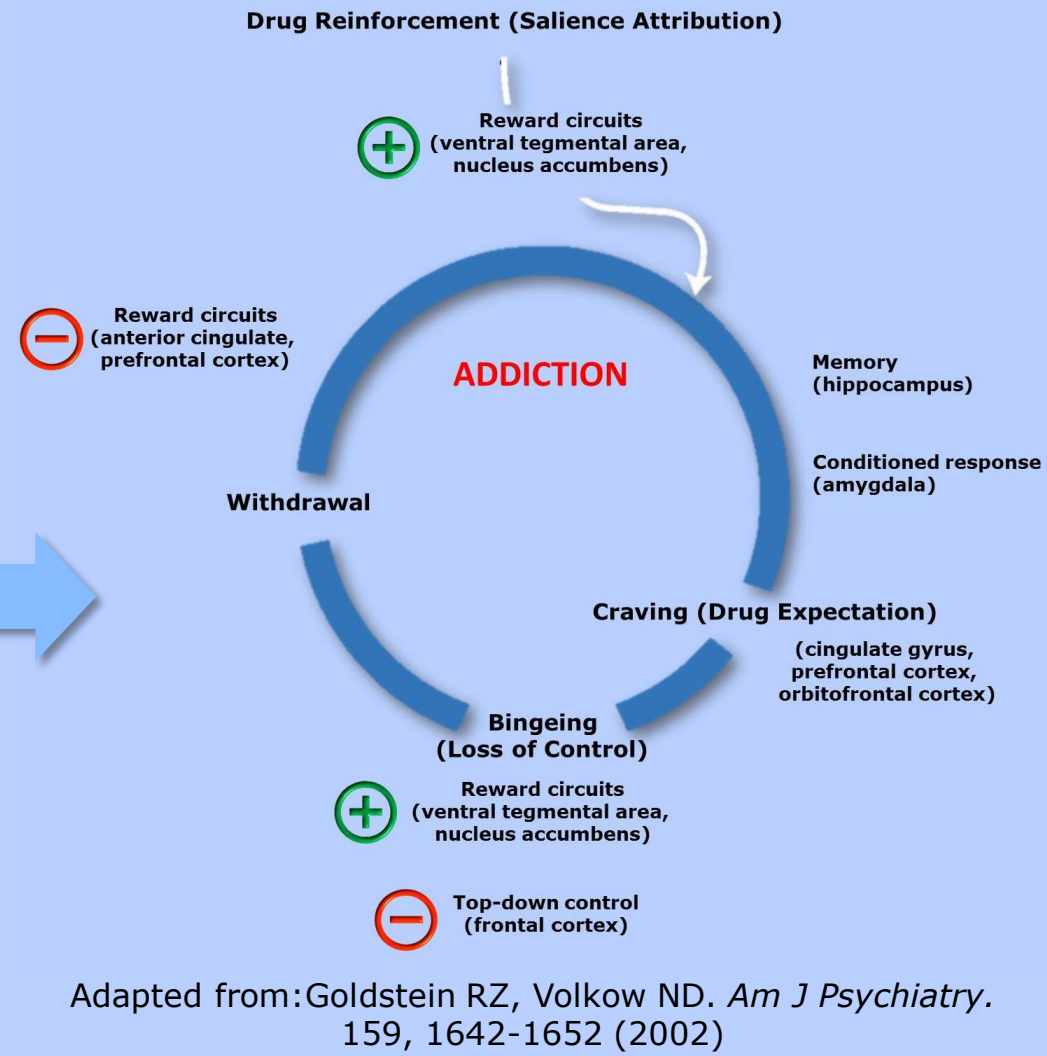
Drug Addiction

Addiction is a chronically relapsing disorder, characterized by:

- Compulsion to seek and take the drug
- Loss of control when intake is limited
- Continuation of drug use despite significant harmful consequences

Drug consumption produces positive reinforcement effects, although long-term consumption will lead to tolerance and dependence effects, generating negative reinforcement, what will only be solved by the consumption of the desired drug.

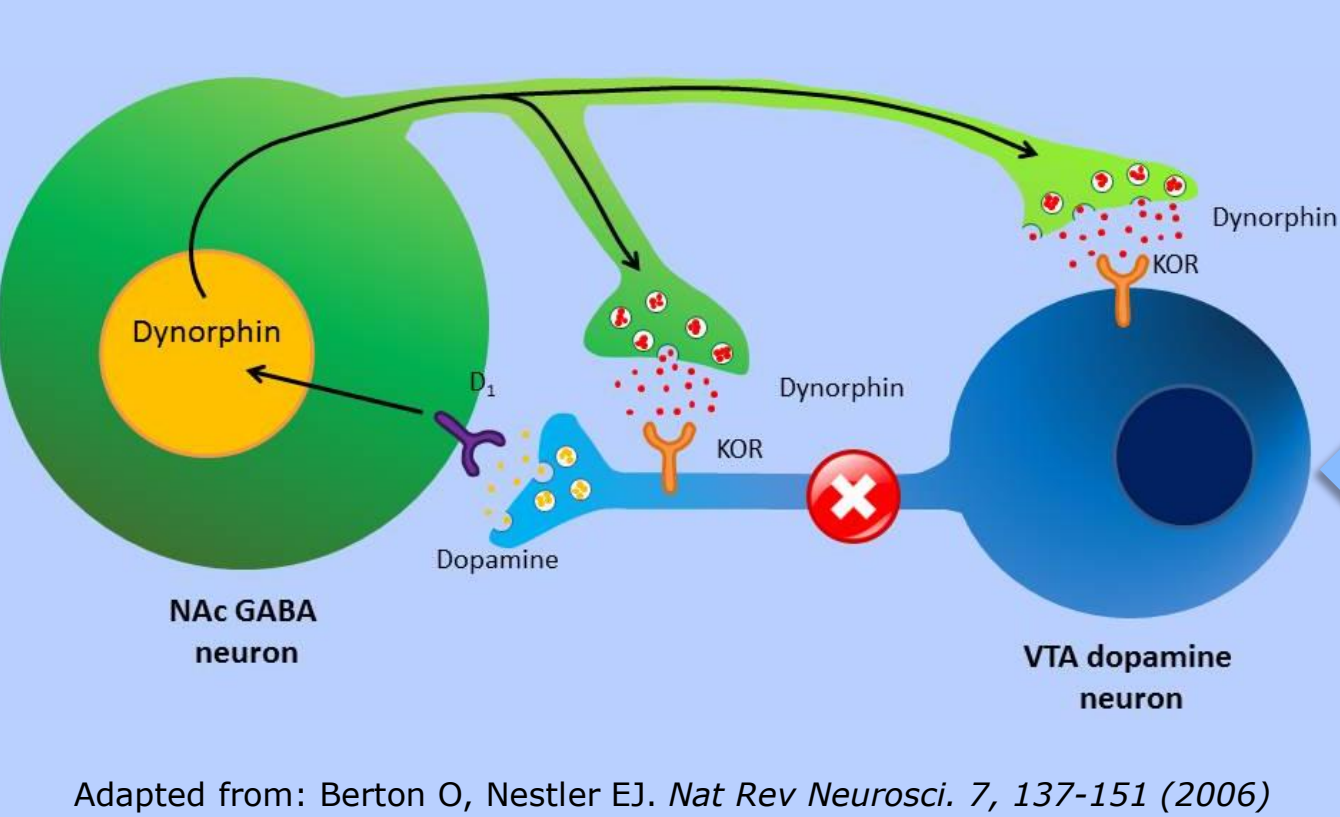
Different drugs have a distinct mechanism of action. Nevertheless, all converge in the activation of the reward system.



Adapted from: Goldstein RZ, Volkow ND. *Am J Psychiatry*. 159, 1642-1652 (2002)

Relation Between Romantic Love And Addiction

Dopamine		Opioids		CRF		Serotonin	
Romantic Love	Drug Addiction	Romantic Love	Drug Addiction	Romantic Love	Drug Addiction	Romantic Love	Drug Addiction
Early-stages		Early-stages		Early-stages		Early-stages	
Reward system is activated to allow rewarding experiences. Dopamine D ₂ receptors promote bonding	Reward system is activated to allow rewarding experiences. Dopamine D ₂ receptors promote drug reward	MOR receptors are activated by endorphins, promoting bonding	MOR receptors are activated by endorphins, promoting bonding	↑CRF: glucocorticoids release promote an initial neophobia that will induce anxiety and stress	↑CRF: promotes acute stress that induces drug intake	↓platelet serotonin transporter: correlating with SNC levels. It promotes obsessive thoughts.	↓platelet serotonin transporter: in obsessive-compulsive disorder, which is characterized by an obsessive behaviour
Maintenance		Maintenance		Maintenance		Maintenance	
↑D ₁ /D ₂ ratio, which inhibits the bonding with a strange partner, thus increasing partner protection	↓D ₂ receptors: diminishing dopamine release (less reinforcing effects) and focusing the subject attention in a drug-seeking behaviour	KOR receptors are activated by dynorphins, inhibiting rewarding experiences and promoting partner maintenance	KOR receptors are activated by dynorphins, mediating a negative mood state and promoting drug intake to prevent such negative state	Oxytocin attenuates the initial neophobia by decreasing CRF levels and promoting the maintenance of the pair bond created	Drug intake diminishes CRF release, promoting rewarding experiences	Normalization of platelet serotonin transporter to the controls' level. The obsessive thoughts diminish as the intimacy increases	Treatment of obsessive-compulsive patients show a normalization in platelet serotonin transporter levels and a decrease in obsessive behaviour
Rejection		Rejection		Rejection		Rejection	
Dopamine release is maintained, expecting the partner's reward	Dopamine release is maintained, expecting the drug's reward	↑dynorphins cause KOR activation, which will induce bad mood and anxiety in the rejected lover	↑dynorphins cause KOR activation, which will promote drug craving	↑CRF: induces stress for the broken bond and anxiety to recover the partner	↑CRF: promotes stress and anxiety that will be reduced by the drug's consumption (withdrawal syndrome)		



Adapted from: Berton O, Nestler EJ. *Nat Rev Neurosci*. 7, 137-151 (2006)

Link between dopamine and opioids

Dopamine release promotes a rewarding reinforcement. Dopamine-D₁ receptor interaction promotes dynorphin release. Dynorphin will bind to KOR receptors, and these will inhibit dopamine rewarding effects.

Romantic love: results in an inhibition of a new pair bond with other potential partner and will focus the lover's attention to the actual partner to protect him or her.

Drug addiction: inhibition will precede to negative mood that will only be solved by drug intake.

Common Neuroanatomy in Romantic Love and Addiction

Early-stage

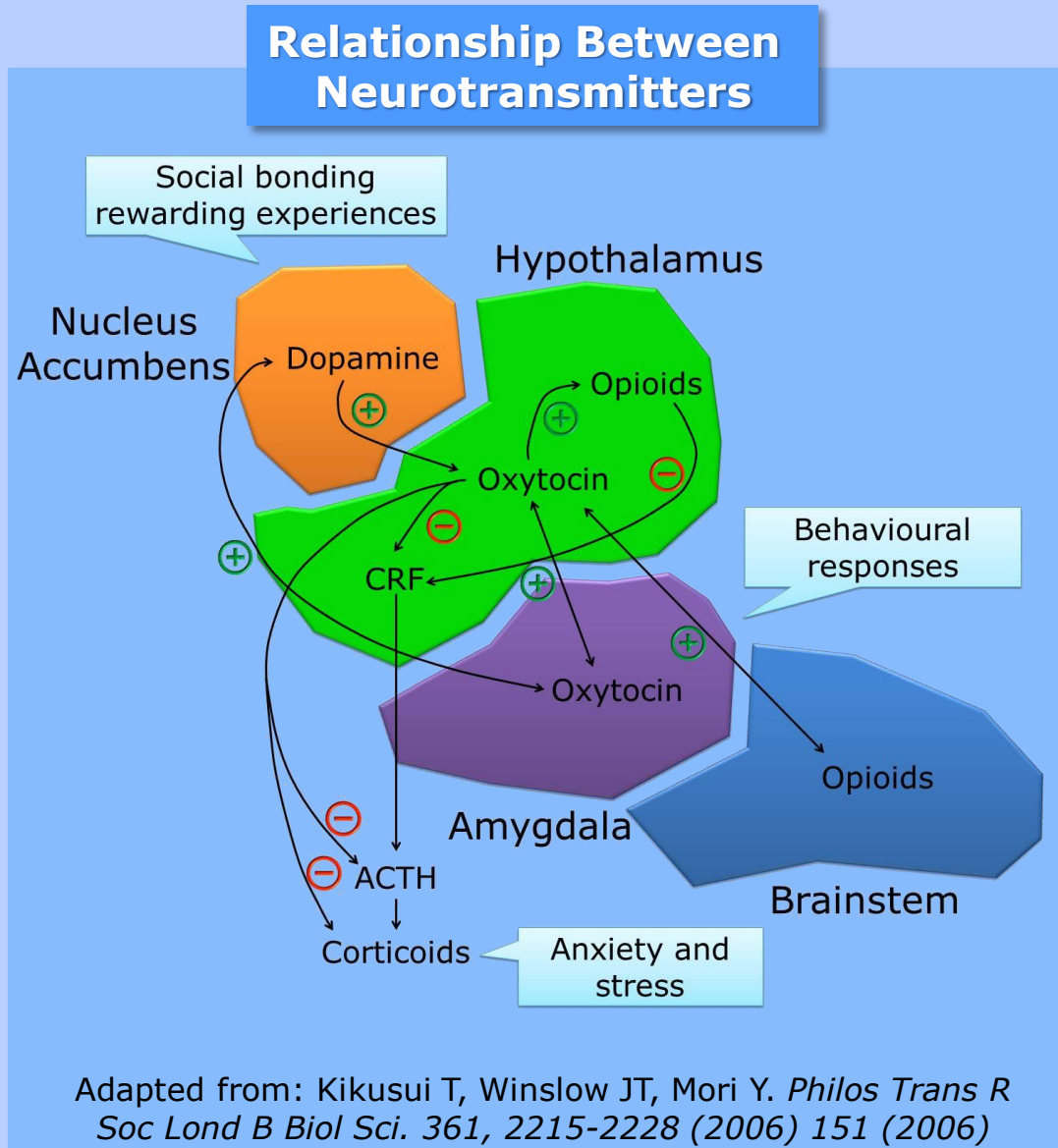
Reward system, amygdala, anterior cingulate area, orbitofrontal cortex, prefrontal cortex

Maintenance

Reward system

Rejection

Reward system, anterior cingulate, area, orbitofrontal cortex, prefrontal cortex



Adapted from: Kikusui T, Winslow JT, Mori Y. *Philos Trans R Soc Lond B Biol Sci*. 361, 2215-2228 (2006) 151 (2006)

Conclusions

- It is possible to establish a relationship between romantic love and addiction, as both share a goal-directed motivation (the partner or the drug). Moreover, both share some neural circuits, involving mainly the reward system.
- Romantic love could be seen as a constructive addiction when it is bidirectional. On the other hand, it could be seen as a destructive addiction when it is rejected.
- Love is a complex emotion that includes basic and complex emotions, some of which could be seen as addictive emotions. Nonetheless, although similarities between both processes are several, we have to keep in mind that there are also many differences between them, in order not to get a precipitated idea.